

THE TREATMENT OF THE STUMP IN APPENDICECTOMY.

BASED ON A PATHOLOGIC AND BACTERIOLOGIC STUDY OF THE APPENDIX.

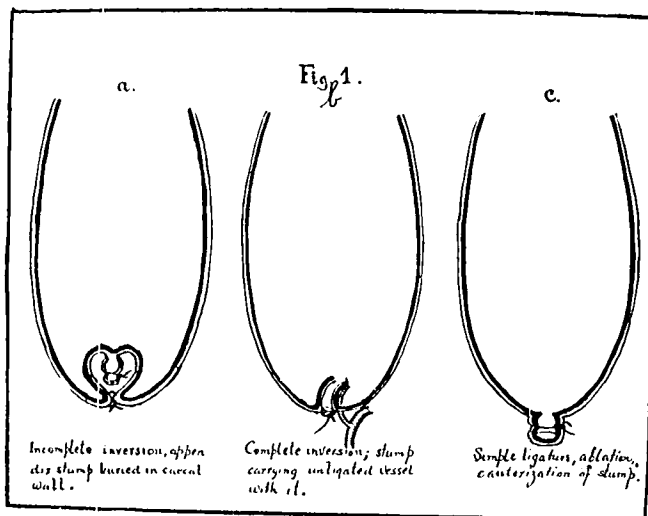
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WE have innumerable casuistic reports on appendicitis, almost as many detailed descriptions of the anatomy and pathology of the appendix, and a proportionately large number of methods of treating the stump. Yet a careful search of the literature fails to reveal a single article in which the special treatment of the stump is based on definite anatomical, pathological, or experimental data. I therefore undertook to discover if it were not possible by a combination of clinical, experimental, and pathological methods, to determine upon one rational method of dealing with the appendix stump; for surely, unless all the methods are equally good, one of them must be the best, and thus be entitled to a place among the so-called "typical operations."

The result of my investigations is, that simple ligature of the appendix, ablation of the organ distally to the ligature, and cauterization of the stump, is the simplest and safest method of dealing with the diseased vermiform appendix. Dogmatism and surgery do not go hand in hand. There will always be cases where the judgment and ingenuity of the operator must regulate the method of procedure. The appendix may be too friable or gangrenous, or the adhesions may be too dense, to permit of simple ligature and cauterization. Yet, in the main, the fact holds good that, in the ordinary run of both acute and interval appendicitis cases, the most rational method of dealing with the appendix consists in simple ligation, fol-



lowed by cauterization. Whether the cauterization be done with the actual cautery or with pure carbolic acid makes no material difference. Personally, I prefer the actual cautery, because the heat exerts a bactericidal action at some distance from the point of application of the incandescent platinum, whereas the acid acts only on the surface. Moreover, by dividing the appendix with the cautery one guards against the escape of feces, and consequent infection of the operation field.

In general, the methods of treating the stump may be grouped under three heads, as follows:

(a) Ligation of the base of the appendix, ablation of the organ distally to the ligature, and inversion of the stump by means of Lembert sutures passed through the peritoneum of the cæcum. (Fig. 1, a.) In these cases the appendix stump is *inverted into the wall of the cæcum*.

(b) Ablation of the organ without previous ligation of its base, and inversion of the stump *into the lumen of the cæcum*; Lembert sutures over the site of inversion. (Fig. 1, b.)

(c) Simple ligation, ablation of the organ distally to the ligature, and cauterization of the stump. (Fig. 1, c.) The disinfected stump is dropped back into the peritoneal cavity.

I shall try to show that both methods, *a* and *b*, are dangerous, and that method *c* is not only free from these dangers, but also possesses distinct advantages.

In method *a* the appendix stump is invaginated into the *cæcal wall*. It is impossible to invaginate it into the cavity of the cæcum, because the base of the appendix has been ligated preliminary to ablation of the organ. A glance at Fig. 1, a, will show that we have buried an infected stump in a closed cavity. If the stump has been cauterized, and thus disinfected, before inversion into the cæcal wall, the method is nevertheless a dangerous and unreliable one; for the inevitable exudate that forms is bottled up in a cavity under conditions which are particularly favorable to abscess formation. That such a procedure is likely to lead to serious trouble is not merely an *a priori* deduction, for Herman¹ reports a case from Professor

Rydygier's clinic, where, five days after an interval appendicitis operation, in which the stump was treated thus, an abscess formed in the cæcal wall, perforated into the general peritoneal cavity, and caused death.

Covering the ligated stump with a previously prepared cuff of peritoneum is only a modified way of locking it up in a closed space, and is open to the same objections. Professor Riedel, who, of all the German operators, has been most zealous in his advocacy of American methods of dealing with appendicitis, says: "I consider the suturing of a peritoneal cuff over the appendix stump as a very dangerous procedure. As regards going so far as burying the infected stump in the cæcal wall, this must absolutely lead to perforation into the lumen of the cæcum. If the inverting sutures hold, and the adhesions are strong enough, we need not fear an intraperitoneal rupture, but need only consider the disadvantage resulting from an ulcer in the cæcum as a result of the intracæcal rupture."² Riedel draws attention also to the insecurity of this method, in those cases where the cæcal wall is infiltrated and brittle, as it so often is in cases of acute appendicitis.

In method *b* the appendix stump is inverted directly into the lumen of the cæcum. There is therefore no danger of imprisoning a stump exudate, for drainage into the cæcal pouch is complete. We are, however, brought to face two other serious dangers. In this method it is impossible to pass a ligature around the base of the appendix, for such a ligature would prevent complete inversion of the stump. The result is, that for a time at least, the field of operation is in free communication with the infected cavity of the fæces-laden cæcum. Sudsuki³ has shown that in 57 per cent. of the 500 cases that he examined, the lumen of the appendix contained fæces, and Hansemann⁴ goes even farther, saying that fæces are always found in the appendix lumen, irrespective of the presence or absence of Gerlach's valve. On theoretical grounds, therefore, if on no others, it is not advisable or surgical to expose the operative field deliberately to a source of infection, if such a step can be avoided.

This, however, is not the only objection to the complete inversion method. The objection about to be mentioned has, with one exception, never been brought out in surgical literature. I refer to the danger of secondary hæmorrhage. The accounts of the blood supply as given by Nothnagel,⁵ Fowler,⁶ Deaver,⁷ and all the larger hand-books of anatomy, are as follows:

"An anastomosis takes place between the superior mesenteric, ileocolic, right and middle colic arteries by means of arches, from which secondary loops are given off. From one of these secondary loops an appendicular artery arises, in connection with a branch which supplies the caecal region. The appendicular branch, the essential nutrient artery of the appendix, passes along the free edge of the mesenterium, giving off branches to the appendix along the way. In case the mesentery is absent, *the artery passes beneath the peritoneal coat*. In exceptional cases the vessel may pass directly to the tip of the organ, and then be reflected into the submucosa."⁶ The anatomic fact that in a fair proportion of cases the appendicular artery runs in the wall of the appendix is one of prime importance, and yet one which has received no clinical recognition, except in an article by Fowler, to be quoted later.

Without stating any reasons or authorities, Murphy, in his most recent article on appendicitis, summarily dismissed as untrue a fact firmly established both by anatomists and surgeons. He says, "The appendix has no vessel running parallel to its long axis; the vessels of the meso-appendix run directly through the mesentery, to the appendix wall."⁸ Kelynak⁹ states that the mesenterium is lacking in a small proportion of cases and is rudimentary in a large proportion. Ferguson,¹⁰ of Toronto, examined 200 cadavers, and found the mesenterium absent in 50 per cent. of them. Monks and Blake¹¹ in 650 autopsies found an absence of the mesenterium in 16 per cent. of the cases. In all of these cases the vessel runs in the wall and parallel to the long axis of the appendix, and is caught only by ligating the tube as a whole or by dissecting out the vessel. Yet an essential point in the method of complete

inversion is that no ligature be passed around the appendix. It is for this reason that Fowler characterizes the method as "a brilliant device, lacking the element of safety."¹²

Here, again, clinical facts prove that the danger is a real and not a supposed one. Fowler states:

"The possibility of the existence of a sufficiently large vessel in the wall of the appendix, from which hæmorrhage might occur, suggested itself to me early in the use of Dawbarn's (complete inversion) method, and this was verified by experience later."¹² The case in question had four hæmorrhages of bright red blood (sixteen ounces in all, besides several large clots) which told markedly on the condition of the patient, but which, fortunately, responded to the administration of opium. A careful examination of the rectum failed to reveal any cause for the hæmorrhage, and Fowler concluded that the bleeding came from the appendicular artery.

This is the only case that I can find on record, and yet I have not the slightest doubt that the accident is one of not uncommon occurrence. I myself assisted at an operation followed by similar disagreeable hæmorrhages. The case was operated upon by Dr. Charles Elsberg, at Mt. Sinai Hospital, New York City, and I am indebted to Dr. Elsberg for the notes on the case. The operation was done under local anæsthesia (owing to a mitral valvular lesion). Dawbarn's method of complete inversion of the stump was executed. Twenty-four hours after the operation the patient complained of intense abdominal cramps. An enema was given, and was followed by the expulsion of about eight ounces of bright red blood and numerous clots (no hæmorrhoids or other rectal lesions). The patient gave every evidence of this hæmorrhage, his pulse ranging from 118 to 128. After twenty-four hours of comparative quiet, the cramps again set in, and were again followed by the show of a copious hæmorrhage, followed later in the day by smaller quantities of blood. Under dermatol and opium, with absolute quiet, the hæmorrhages ceased.

Dr. Charles Mayo, of Rochester, Minnesota, kindly sent me the notes of a case similar, in practically all its details, to

the two already quoted, except that he crushed the base of the appendix with an enterotribe before inverting it. The patient, "thirty-six hours after operation, began to pass copious, bright red, bloody stools," as a result of which the pulse-rate ran up to 150 beats to the minute. The symptoms, although alarming for forty-eight hours, finally responded to treatment. Dr. Mayo explained the hæmorrhage on the basis that some branch of the appendicular artery had not been ligated. Hæmostasis is certainly as basic a law of surgery as is asepsis, and on this ground alone it seems to me irrational to execute a method, following which we may encounter a hæmorrhage, in however small a proportion of cases.

Fowler¹² brings to bear even another objection to the method. He states that we are never sure of having inverted the stump into the *lumen* of the cæcum. He thinks that, in a certain number of cases, it is merely crowded in somewhere between the mucous and serous coats of the cæcum, where it may slough and cause a pericæcal abscess. He quotes a case of his, where he inverted the stump into the cæcal lumen, as he thought, but where he found it at autopsy lying between the mucosa and muscularis.

Thus far, then, I have tried to show that incomplete inversion (into the cæcal wall) and complete inversion (into the cæcal lumen) are, in theory and practice, unsurgical procedures. It remains merely to demonstrate that simple ligation of the appendix, ablation distally to the ligature, and cauterization of the stump, is a safe and rational method. In order to show this I shall resort to experimental and clinical proofs, demonstrating that the objections urged against the method are not tenable. And in demonstrating this, I hope to develop facts showing that the method possesses distinct advantages.

One of the main objections to the method is that the ligature forces mucous membrane into apposition with mucous membrane, and that we cannot therefore hope to secure firm union. Morris¹³ says: "In ligating an *artery*, opposed surfaces of the tunica intima become adherent; whereas, in an

appendix the opposed surfaces of the mucosa, or of bared lymphoid tissue, do not become adherent," and "the bacteria in the lumen of the appendix are quick to attack the ring of tissue disabled by the compression anæmia, under the ligature, and thus cause perforation." These two statements practically conventionalize one serious arraignment that has been brought against the method of simple ligature and cauterization.

In order to investigate the matter, I ligated various appendices with catgut and silk, and then made serial sections through the ligatured portion parallel to the long axis of the appendix. Invariably I obtained the same picture as shown in Fig. 2, which represents a section taken directly through the centre of a ligated appendix. As may be seen, mucosa is not brought into contact with mucosa, as Dr. Morris states, but is crowded back for fully one-eighth of an inch (viewed macroscopically) on both sides of the ligature, and, moreover, so crowded back as to close off the lumen completely, and thus prevent the germs in the appendicular lumen from attacking the so-called line of "compression anæmia." Moreover, as may be seen, the stump is quadruply fortified, in that it is covered over by (1) the pulpy lymphoid tissue, (2) a thick layer of the resistant submucosa, (3) a layer of muscularis, (4) a layer of serosa, in addition to being shut off by the infolding of the mucosa.

Ochsner¹⁴ rightly remarks that no other tube in the body, so small as the appendix, contains so large an amount of muscular tissue; and it is this excess of muscular tissue which, in part, fortifies our stump. A ligature properly tied around an appendix crushes aside all the coats exactly as does the Doyen enterotribe when applied to the intestine. I can find no record in literature of a microscopical study of the effect of a ligature on the appendix. Rousse¹⁵ studied the effect of a ligature on the Fallopian tube, and found that, when properly applied, the ligature caused almost exactly the same picture that I have described in the case of the appendix. By this means he disproved the contentions of the Fraenkel school, that the tube lumen was not obliterated permanently

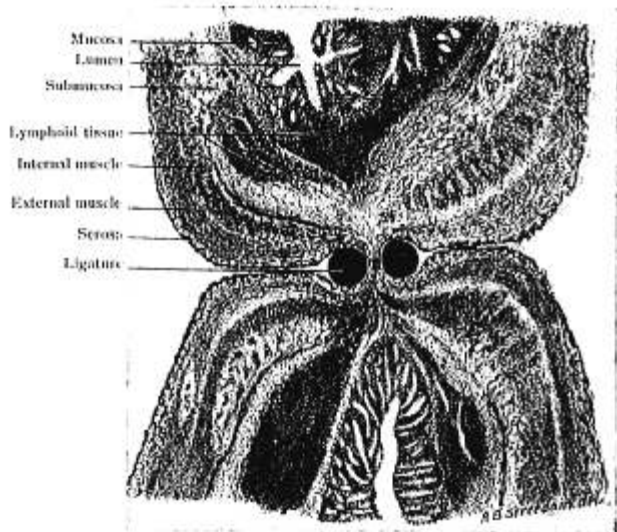


FIG. 2.—Showing the appendicular lumen shut off by the retraction and infolding of the mucosa, and the closure thus formed, protected and reinforced by all the other layers.

by simply ligating it. Lilienthal¹⁰ has described the macroscopical pulpification of the mucosa as the result of a ligature, but the true nature of stump formation is best seen in the microscopical sections.

As regards Morris's statement that perforation occurs after simple ligation of the stump, I can only say that during my two and a half years' internship at Mt. Sinai Hospital, where we operated upon from 300 to 500 cases of appendicitis a year, I never encountered a perforation in a case where the ligature was applied about an appendix, in a non-gangrenous and not too friable area; moreover, Dr. Howard Lilienthal informs me that this same statement holds good for his twelve years of service as adjunct and attending surgeon to the same institution.

The next serious objection to the method is that it leaves uncovered, in the free peritoneal cavity, an infected stump. In our operative technique, we always disinfect the stump, either with pure carbolic acid or with the actual cautery. In order to ascertain whether these methods secured perfect sterilization, I ligated several appendices and cauterized the stumps with carbolic and the cautery. Dr. Libman, assistant pathologist to Mt. Sinai Hospital, kindly took these appendices in charge. Those that had been treated with carbolic acid he washed in sterile salt solution in order to get rid of any possible excess of the acid, which might otherwise interfere with bacterial growth. After a two weeks' stay in sugar bouillon, the media showed absolutely no growth, and Dr. Libman reported the stumps to be sterile. The argument, therefore, that an *infected* stump is left in the peritoneal cavity does not hold good. Of course, these stumps do pour out a secretion after cauterization, but there is no structure in the human organism better fitted to take care of this secretion than is the peritoneum.

The only remaining argument against the method is, that an uncovered stump leads to the formation of adhesions which so frequently distress the patient after operation. To disprove this statement, I can call to my aid only data collected from

post-mortem findings. I have examined, post-mortem, the cæcum of two patients who had previously been operated upon by the simple ligature and cauterization method for appendicitis. In both instances, that portion of the cæcum where the longitudinal striæ meet to mark the site of the appendix was perfectly smooth and glistening. Nowhere was the original site of the appendix base to be found.

Lilienthal¹⁶ states that an adhesion forms to the cauterized end of the stump, and that as the stump sloughs off this adhesion drags it away from the cæcum. In a personal communication to me, Dr. Lilienthal states that he has examined several cases post-mortem, with the end in view of investigating the question of adhesion formation about the appendix stump after ligature and cauterization. In every case (he confined his examinations only to cases where adhesions did not exist before operation) he found the cæcum free from adhesions, with a small, smooth, dimpled spot to mark the former point of origin of the appendix. One of the cases that he examined had died seventy-two hours after operation, and even in this case the cæcum was perfectly smooth, the site of the appendix being discovered only after a careful search.

We know that the tendency of the peritoneum to form adhesions, displaying itself sometimes in a most erratic fashion, has not been explained by any suitable hypothesis. Presumably, according to Nothnagel,¹⁷ the primary cause of adhesion formation resides in the fact that endothelial cells have been destroyed by trauma or inflammation, and their place taken by connective tissue. According to this theory, simple incision or local inflammation of the peritoneum may lead to the development of localized or widespread adhesions. Nothnagel further says that "adhesive inflammation may be circumscribed to a small area of the peritoneum . . . and may develop from the very outset of a diseased condition of the appendix, the adhesion formation then running a slow and insidious course." If, therefore, the genesis of adhesion formation lies primarily in the appendicular inflammation, it is impossible to claim the assurance for any one method of treat-

ment, that adhesion formation will positively not occur. For example, Eliot¹⁸ reports that after an appendicectomy done by the method I am defending, adhesions formed, causing intestinal obstruction. He therefore forsook the method and adopted the procedure of inverting the stump and covering it with peritoneum. Following this method, however, he reports that he also encountered a case of obstruction due to adhesions around the site of inversion.

The point is, that if adhesions form around the site of inversion, they form to stay and make trouble, whereas, if they attach themselves to a stump which has been ligated tightly enough, their traction on that stump will tend to hasten its separation from the cæcum, thus doing away with the pain consequent upon the pull of the adhesions, and obviating the possibility of intestinal obstruction due to a band.

I have tried to show that the method of simple ligation and cauterization is an absolutely safe one, whereas the other methods are all open to serious criticism both from theoretical and practical view-points. It is not my intention strenuously to contend that there is one, and only one, method of dealing with the appendix stump. There is no cut and dried rule that can be made to fit any one surgical procedure. However, I do feel that it is rational to adopt that method which, possessing all the elements of safety, can yet be more speedily accomplished than all other methods. Saving of time, even though that time be reckoned in minutes, is a great surgical desideratum. My last plea for the simple ligation method is that it undeniably does save time.

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